Executive Summary

Star Organics, L.L.C. (Star Organics) has developed Soil Rescue to reduce the mobility of metals in soils. During September 1998, an in-situ application of the technology was demonstrated under the U.S. Environmental Protection Agency's (EPA) Superfund Innovative Technology Evaluation (SITE) Program on soil contaminated with lead at two sites in Roseville, Ohio.

The purpose of this innovative technology evaluation report (ITER) is to present information that will assist Superfund decision makers in evaluating Soil Rescue for application at a particular hazardous waste site. This report provides an introduction to the SITE program and Soil Rescue and discusses the demonstration objectives and activities (Section 1); evaluates the technology's effectiveness (Section 2); analyzes key factors related to application of the technology (Section 3); analyzes the costs of using the technology to reduce the mobility of lead in soil, as well as the soil lead bioaccessibility (Section 4); summarizes the technology's current status (Section 5); and presents a list of references (Section 6).

This executive summary briefly summarizes the information discussed in the ITER and evaluates the technology with respect to the nine criteria applied in Superfund feasibility studies.

Technology Description

Star Organics claims that the metal complexes formed by Soil Rescue immobilize metals, thereby reducing concentrations of leachable metals in soils and reducing the risks posed to human health and the environment. Soil Rescue, as described by Star Organics, is a mixture of weak organic acids and phosphoryl esters that act as metal-complexing agents. In the complexation reaction, coordinate covalent bonds are formed among the metal ions, the organic acids and esters, and the soil substrate. Soil Rescue can be applied to the surface or pressure-injected to a depth of 15 feet into contaminated soil. If necessary, the application can be repeated until the concentrations of leachable metals in the soil are reduced to a level lower than applicable cleanup standards.

Overview of the SITE Demonstration

The SITE demonstration of Soil Rescue was conducted in September 1998 at two sites in Roseville, Ohio: an inactive pottery factory and a trailer park. Both sites are located in the Crooksville/Roseville Pottery Area of Concern (CRPAC). Historically, the CRPAC was a major pottery manufacturing area. Lead was used in the glazing process of the pottery finishing process; as a result, has contaminated the upper portion of the soil layer. Soil samples collected by the Ohio Environmental Protection Agency (OEPA) in 1997 indicated that elevated levels of lead were present in the CRPAC. Waste disposal practices and residue from the operation of the kiln at the inactive pottery factory may have contributed to contamination of the soil adjacent to the factory. Waste from several pottery factories in the CRPAC was used as fill material in the vicinity of the trailer park. The fill material may be the source of the lead contamination of the soil at the trailer park.

For the SITE demonstration, soil samples were collected before and after application of Soil Rescue to evaluate whether the technology could achieve the treatment goals of the demonstration project. The project had two primary objectives and four secondary objectives.

The primary objectives of the SITE demonstration were:

- Primary Objective 1 (P1) - Evaluate whether Soil Rescue can treat soils contaminated with lead to meet the Resource Conservation and Recovery Act (RCRA)/Hazardous and Solid Waste Amendments (HSWA) alternative universal treatment standard (UTS) for land disposal of soils contaminated with lead that meet the definition of a hazardous waste. The alternative UTS for lead in such soil is determined from the results of the toxicity characteristic leaching procedure (TCLP). The alternative UTS for lead is met if the concentration of lead in the TCLP extract is no higher than one of the following: (1) 7.5 milligrams per liter (mg/L), or (2) 10 percent of the lead concentration in the TCLP extract from the untreated soil. The alternative

UTS is defined further in Title 40 of the Code of Federal Regulations (CFR), Chapter I, part 268.49 (40 CFR 268.49).

- Primary Objective 2 (P2) - Evaluate whether Soil Rescue can decrease the soil lead bioaccessibility by 25 percent or more, as defined by the Solubility/Bioaccessibility Research Consortium's (SBRC) In-Vitro Method for Determination of Lead and Arsenic Bioaccessibility (simplified in-vitro method [SIVM]) (Note: the EPA Lead Sites Workgroup (LSW) and Technical Review Workgroup for lead (TRW) at this time do not endorse an in vitro test for determining soil lead bioaccessibility [ITRC 1997]).

The secondary objectives of the demonstration were:

- Secondary Objective 1 (S1) - Evaluate the long-term chemical stability of the treated soil.

- Secondary Objective 2 (S2) - Demonstrate that the application of Soil Rescue did not increase the public health risk of exposure to lead.

- Secondary Objective 3 (S3) - Document baseline geophysical and chemical conditions in the soil before the application of Soil Rescue.

- Secondary Objective 4 (S4) - Document the operating and design parameters of Soil Rescue.

SITE Demonstration Results

Summarized below are the significant results of the SITE demonstration:

- Soil Rescue reduced the mean TCLP lead concentration from 403 mg/L to 3.3 mg/L, a reduction of more than 99 percent. Therefore, the treated soil meets the alternative UTS for soils contaminated with lead, as specified at CFR 268.49.

- Analysis of the data generated by application of the SIVM demonstrated that Soil Rescue reduced the soil lead bioaccessibility by approximately 2.9 percent. However, it was recognized early on that meeting this goal would be difficult because the SIVM test procedure used in the demonstration involves a highly acidic sample digestion process, which may be revised in the future, because it may be exceeding the acid concentrations that would be expected in a human stomach.

- Soil treated with Soil Rescue appears to exhibit long-term chemical stability, as indicated by the results of most of the 11 analytical procedures that were conducted to predict the long-term chemical stability of the treated soil. However, the results of some of the analytical procedures suggest that Soil Rescue does not appear to exhibit long-term chemical stability.

  In summary:

— Long-term soil chemical stability was indicated for soils treated by Soil Rescue at both test locations, as indicated by the analytical results of the multiple extraction procedure (MEP), pH, and cation exchange capacity (CEC) test procedures. The CEC results are considered to be qualitative, because this test was conducted on only a single sample from each location.

— Long-term chemical stability was indicated at one site, but not indicated at the other, by the analytical results of procedures for evaluating acid neutralization capacity, and leachable lead by the simulated precipitation leaching procedure (SPLP). The results from the procedure for evaluating lead speciation by sequential extraction indicated chemical stability inconclusively at one site, but not at all at the other. The results of tests on acid neutralization capacity are considered to be qualitative, because this test was conducted on only a single sample from each location.

— The analytical results from the lead speciation test by scanning electron microscopy (conducted only on soils from the trailer park) were inconclusive, in that some soluble phases of lead were reduced, while the organic matter phase of lead was increased (organically bound lead can be released if the organic phase is biologically degraded by microbes in the soil).

— At both locations, long-term chemical stability was not indicated for soils treated by Soil Rescue, as indicated by the analytical results from oxidation-reduction (Eh) analysis, two types of total lead analyses (one using nitric and the other using hydrofluoric acid); analysis for total phosphates; and analysis for leachable phosphates by the SPLP (It should be noted that the tests involving two types of total lead analysis were extremely aggressive tests, thus meeting the acceptance criteria established for these tests was not as important as meeting the acceptance criteria of other tests involving long-term chemical stability).

- On the basis of information obtained from the SITE demonstration, Star Organics, and other sources, an economic analysis examined 12 cost categories for a scenario in which Soil Rescue was applied at full scale to treat 807 cubic yards (yd^3) of soil contaminated with lead at a 1-acre site at CRPAC. The cost estimate assumed that the concentrations of lead in the soil were the same as those encountered during the Roseville demonstration. On the basis of those assumptions, the cost was estimated to be \$40.27 per yd^3 of treated soil, which is a site-specific estimate.

Superfund Feasibility Study Evaluation Criteria for the Soil Rescue Technology

Table ES-1 presents an evaluation of Soil Rescue with respect to the nine evaluation criteria used for Superfund feasibility studies that consider remedial alternatives for superfund Sites.

Table ES-1. Evaluation of Soil Rescue by Application of the Nine Superfund Feasibility Study Criteria

	Criterion	Discussion
1.	Overall Protection of Human Health and the Environment	The technology is expected to significantly lower the leachability of lead from soils as indicated by the TCLP results, thereby reducing the migration of lead to groundwater and the potential for exposure of all receptors to lead; however, the technology did not significantly reduce soil lead bioaccessibility, as determined by the SIVM.
2.	Compliance with Applicable or Relevant and Appropriate Requirements (ARAR)	During the SITE demonstration, Soil Rescue reduced the mean TCLP lead concentration from 402 mg/L to 3.3 mg/L, a reduction of more than 99 percent. Further, the treated TCLP lead concentrations were less than the alternative UTS for lead in soil. Therefore, the treated soil met the land disposal restrictions (LDR) for lead-contaminated soil, as specified in 40 CFR 268.49. However, the technology's ability to comply with existing federal, state, or local ARARs should be determined on a site-specific basis.
3.	Long-term Effectiveness and Permanence	The analytical results of procedures for the multiple extraction procedure (MEP) lead, pH, and cation exchange capacity (CEC) suggest long-term chemical stability of the treated soil. The analytical results of a number of other procedures do not suggest long-term chemical stability of the treated soil. Those procedures included two types of total lead analyses, analysis for total phosphates, and analysis for SPLP phosphates. The results related to long-term effectiveness from the test for lead speciation by scanning electron microscopy and lead speciation by sequential extraction, Eh, acid neutralization and SPLP lead were inconclusive.
4.	Short-term Effectiveness	Short-term effectiveness is high; surface runoff controls may be needed at some sites.
5.	Reduction of Toxicity, Mobility, or Volume Through Treatment	The mean TCLP lead concentration was reduced from 403 mg/L to 3.3 mg/L, reducing the mobility of the lead in the soil.
6.	Implementability	The technology is relatively easy to apply. Contaminated areas can be treated with a fertilizer sprayer for treating soils to a depth of 6 inches and a pressure injection apparatus for treating depths of more than 6 inches.
7.	Cost	For full-scale application of the technology at a 1-acre site contaminated with lead in the top 6 inches of soil, estimated costs are \$32,500, which is \$40.27 per cubic yard of soil treated.
8.	Community Acceptance	Community acceptance of Soil Rescue likely will be a site-specific issue.
9.	State Acceptance	State acceptance of Soil Rescue likely will be a site-specific issue.